ORDER

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8200.43

4/30/04

SUBJ: Flight Inspection of the Microwave Scanning Beam Landing System (MSBLS)

1. PURPOSE. This order details the flight inspection procedures, requirements, and analysis for the evaluation of the Microwave Scanning Beam Landing System (MSBLS).

2. DISTRIBUTION. This order is distributed to the National Aeronautics and Space Administration; to the Federal Aviation Administration Aviation System Standards NASA Program Manager, Flight Inspection Operations Division, and International Flight Inspection Office.

3. BACKGROUND. The MSBLS is designed to provide azimuth and elevation angles and distance information exclusively to NASA's Space Transportation System (STS) Shuttle Orbiter during final approach and landing at selected landing sites.

4. RELATED PUBLICATIONS.

a. NSTS 07700 Volume X, Book 3

b. FAA Order 8200.1 (current edition), United States Standard Flight Inspection Manual (USSFIM)

c. FAA Order 8240.36 (current edition), Instructions for Flight Inspection Reporting

d. FAA Order 1350.15, Records Organization, Transfer, and Destruction Standards

e. Space Shuttle Interface Control Document ICD-2-1D003, 4/30/97

5. FLIGHT INSPECTION PROCEDURES ANALYSIS, AND TOLERANCES. Appendix 1 contains background material concerning the MSBLS system. Appendix 2 contains the flight inspection procedure, requirements, and analysis for MSBLS certification.

6. INFORMATION UPDATE. Any deficiencies found, clarifications needed, or suggested improvements regarding the contents of this order should be noted on FAA Form 1320-19, Directives Feedback Information. If an interpretation is needed, call the originating office for guidance. FAA Form 1320-19 should be used as a follow-up to the verbal conversation.

/s/

Thomas C. Accardi
Program Director of Aviation
System Standards

Distribution: A-W(VN-7/ 200/ IFIO); **Initiated By: AVN-230**
Special NASA Addressees

APPENDIX 1

BACKGROUND MATERIAL
FOR THE
MICROWAVE SCANNING BEAM LANDING SYSTEM (MSBLS)

1. Introduction. The Microwave Scanning Beam Landing System (MSBLS) is a Ku-band (15.4 to 15.7 GHz) precision approach and landing system which provides slant range, azimuth, and elevation data to the Space Transportation System (STS) Shuttle Orbiter from approximately 18,000 ft and 15 nm through touchdown.

a. Unlike a conventional microwave landing system used in the NAS, the MSBLS does not provide a published procedural azimuth track at a fixed angle of descent. It provides the Shuttle's Guidance, Navigation, and Control (GN&C) computer continuous digital azimuth, elevation, and range signal offsets relative to the appropriate MSBLS antenna phase center. The GN&C computer, in turn, steers the Shuttle on a programmed approach and landing profile containing multiple azimuth tracks and elevation angles.

b. MSBLS DME, due to the 15.4 – 15.7 GHz transmit frequency, cannot be received using conventional DME receivers.

c. Each runway at an STS landing site has two MSBLS siting possibilities: MSBLS Ground Station (**MSBLS-GS) or** MSBLS Junior (**MSBLS-JR)** configurations.

(1) The **MSBLS-GS** configuration provides azimuth and DME through landing rollout, and elevation to touchdown. Two equipment shelters are included; one for azimuth/ distance, the other for elevation. Both shelters contain primary and standby equipment and antennas (strings). (See Figure 1)

(a) Azimuth/ DME and elevation shelters are both located 300 ft offset right or left from runway centerline (500 ft at military installations).

(b) The azimuth/ DME shelter is located 1,300 ft beyond the rollout end of the runway. *Newer MSBLS-GS installations may have the azimuth sited 1,500 ft prior to the rollout end of the runway.*

(c) The elevation shelter is located 3,360 ft from runway threshold. *Newer installations may have the elevation sited 1,500 ft from threshold.*

(2) The collocated **MSBLS-JR** configuration provides azimuth/ DME and elevation guidance up to runway threshold, but cannot support rollout guidance. Single transmitter/ antenna azimuth and elevation facilities are included in a single equipment shelter. *MSBLS-JRSW configuration includes two MSBLS-JR sites installed side-by-side.* (See Figure 2)

(a) Runway offsets remain the same as the MSBLS-GS configuration

(b) Shelter to threshold distance is a standard 1,500 ft

d. The azimuth and elevation data are broadcast by rapidly oscillating antennas that produce narrow, fan-shaped radio beams, which are pulse-pair encoded with the ground antenna's present pointing angle. The MSBLS provides steering commands to the STS via a highly accurate three-dimensional navigation position to maintain the Orbiter on its proper flight trajectory until over the runway approach threshold, at an altitude of approximately 100 ft. The azimuth transmits a course parallel to the runway centerline.

2. Basic MSBLS Operation

The three MSBLS components operate on a common channel during the STS landing phase. The MSBLS transmits a DME "solicit" pulse. The onboard MSBLS receiver responds with a DME interrogation pulse. The ground equipment responds by transmitting a return pulse. A decoder in the onboard MSBLS decodes the pulses to determine range, azimuth, and elevation. Range is a function of the elapsed time between interrogation pulse transmission and signal return. Azimuth pulses are returned in pairs. The spacing between the two pulses in a pair identifies the pair as azimuth and indicates which side of the runway the Orbiter is on. Spacing between pulse pairs defines the angular position from runway centerline. The spacing between the two pulses in a pair identifies the pair as elevation, and the spacing between two pulse pairs defines the angular position of the Orbiter above the runway.

The azimuth antenna produces a narrow, planar-shaped vertical beam that scans horizontally through the approach volume, 0 to 23° high and 13.5° right and left of runway centerline. This azimuth beam is encoded with the antenna's azimuth angle from 0° azimuth at center of scan. The azimuth information is encoded on the scanning azimuth beam by varying the spacing between pulse pairs. The pulse-spacing code is 60 microseconds at 0° plus two microseconds per degree from 0°. The spacing between pulses in a pair tells the airborne user that azimuth information is being transmitted and whether the angle is in the fly-left portion of coverage (10 microseconds between pulses in a pair) or the fly-right portion of the coverage (14 microseconds between pulses in a pair).

The elevation beam produces a similar, planar-shaped horizontal beam that is scanned vertically 1.3 to 29° high, 25° right and left of runway centerline. The elevation beam is encoded with the antenna's elevation angle from the horizon. The identity spacing (between pulses in a pair) for elevation is 12 microseconds. The code is, once again, 60 microseconds for 0° plus 2 microseconds per degree from 0°.

As the two directional antennas alternately scan through the approach volume, the antennas on the approaching Orbiter vehicle intercept these ground-originated signals when the spacecraft is within the beam of the ground station antennas. The detection circuits within the navigation set accept only those pulse pairs that are above a threshold amplitude level. By placing limits on the number of data spaces (between 8 and 127), errors due to beam shaping and multi-path reflections are minimized. The navigation set decodes the intercepted signals and averages the pulse-pair spacing to obtain the elevation angle of the Orbiter. A similar function is performed for the azimuth angle.

The azimuth and elevation antennas are electronically synchronized so that only one antenna is radiating at any particular time. The azimuth and elevation antennas are oscillated in a sinusoidal fashion. The azimuth antenna oscillates ± 44° about azimuth center, parallel to the runway, but only transmits ± 15° in the same area. The elevation antenna oscillates ± 24° about a 15° rest angle, but transmits only within the sector from 0 to 30° of elevation, above the horizontal.

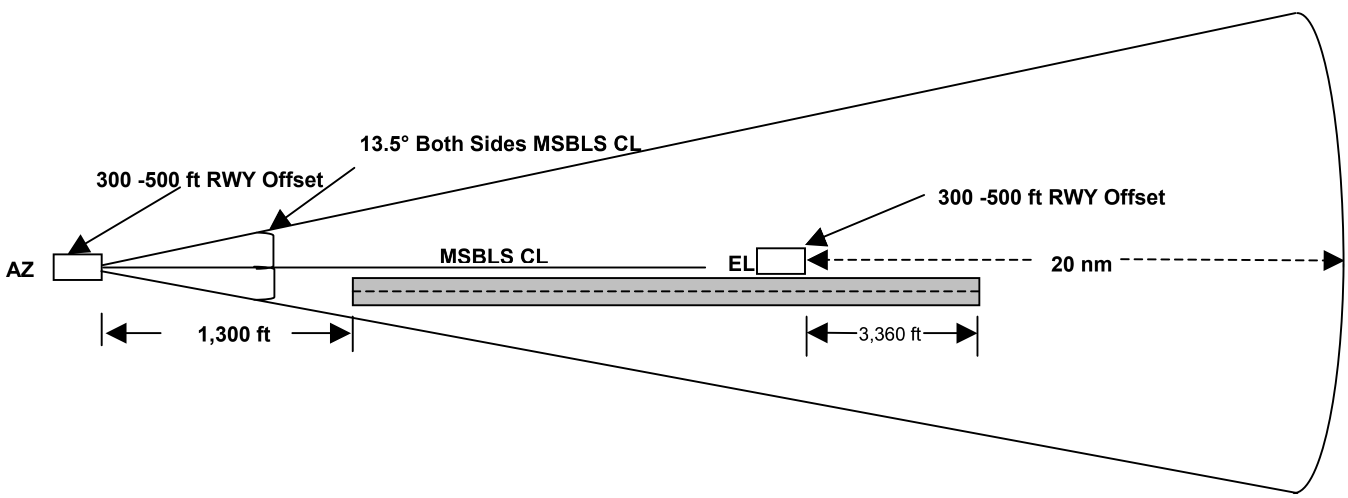
In the time period that precedes the azimuth transmission and follows the elevation transmissions, distance information is transmitted. Once every 200 milliseconds, a set of azimuth, elevation, and distance information is transmitted by the ground station and processed by the airborne navigation receiver.

Azimuth and DME assemblies are co-located on the ground and time share a transmitter. The AZ/ DME ground station is located near the stop-end of the runway to provide centerline guidance and distance information through touchdown and rollout. The elevation station is located near the expected touchdown point to provide touchdown guidance.

The MSBLS has a dual-redundant uninterruptible power supply (UPS). The UPS contains batteries that allow 15 minutes of operation after loss of facility power.

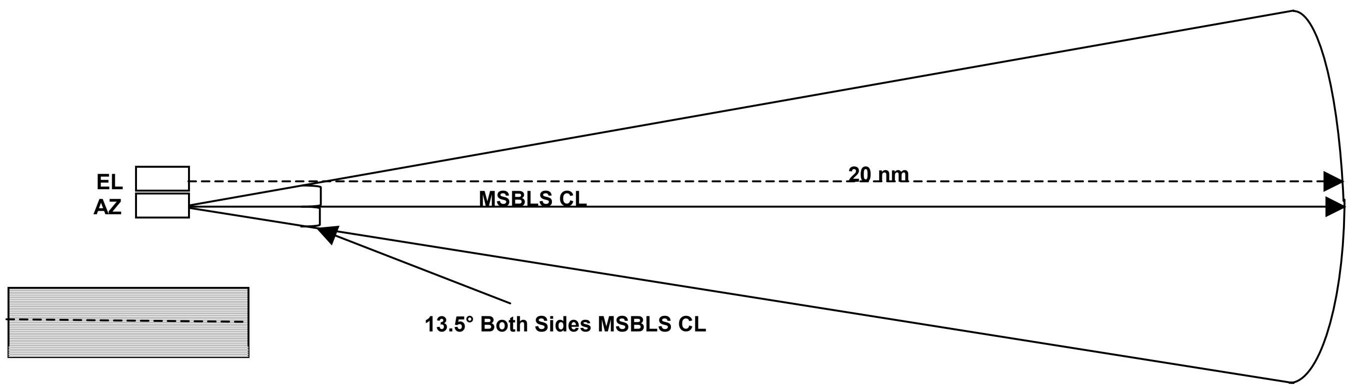
The azimuth and elevation “angle” field monitors are special purpose receiver/ decoders looking for a particular azimuth/ elevation signal. The monitor receives the coded RF signal, converts to a digital form, and accumulates its deviation from the signal it expects to receive. The DME field monitor interrogates the DME ground station as the Orbiter would when it desires distance data.

Figure 1
GS
AZ HORIZONTAL FLIGHT INSPECTION SERVICE VOLUME



1. MSBLS-GS configuration
2. Figure is not drawn to scale
3. Newer installations place the azimuth 1,500 ft prior to the stop-end of the runway.
4. Newer installations place the elevation site 1,500 ft back-set from the threshold.
5. All installations contain dual-string capability.
6. Azimuth service volume distance is 20 nm from the <u>Elevation</u> site.

Figure 2
JR/ JRSW
AZ HORIZONTAL FLIGHT INSPECTION SERVICE VOLUME



1. Azimuth and Elevation facilities are collocated, 1,500 ft back-set from the runway threshold, and offset 300 – 500 ft from runway centerline.
2. Figure is not drawn to scale
3. MSBLS-JRSW facilities contain dual string capability; MSBLS-JR facilities are single string.
4. Azimuth service volume distance is 20 nm from the Elevation site.

APPENDIX 2

FLIGHT INSPECTION EVALUATION OF MSBLS

1. Introduction. This appendix presents MSBLS flight inspection requirements. It is intended to provide guidance to the user and flight inspection personnel concerning the airborne data required for commissioning and periodic system evaluations.

2. Preflight Requirements

a. Facilities Maintenance Personnel shall:

(1) Prepare for flight inspection in accordance with applicable NASA directives.

(2) Provide adequate two-way VHF radio equipment for direct communication between the MSBLS Maintenance/ Engineering personnel and the flight inspection aircraft.

(3) Ensure all MSBLS facility equipment is calibrated in accordance with applicable NASA directives.

(4) Ensure personnel will be available on-site to make corrections and adjustments.

(5) Provide Differential Global Positioning System (DGPS) based differential corrections from each landing site over an RF modem to the flight inspection aircraft.

(6) Provide transportation to move flight inspection equipment and/or personnel.

b. Flight Personnel. Prepare for flight inspection in accordance with FAA Order 8200.1, Section 106.

c. Special Equipment Requirements: Flight inspection aircraft specifically modified with a high precision truth reference capability (Differential GPS), and all antennas, receiver(s), and AFIS modifications necessary to comply with the flight inspection requirements of this order and FAA Order 8200.1, current edition.

d. Facility Data Requirements. NASA will provide AVN initial survey information for ground sites in WGS84 or NAD83 format. This includes survey information on the equipment under test and runways served. NASA will submit the data directly to the FAA Aeronautical Specialist (AVN-210). Once established, changes to this data will be in writing and contain all revised data elements, including survey data, reference datum, locations, and facility offset values. If the data to be changed affects any published approaches, NASA will submit the data through the FAA Regional Flight Procedures Office (FPO). The FAA will then disseminate the changed data to AVN. The Flight Inspection Technical Support Branch, AVN-210, shall approve all facility data prior to the flight inspection.

3. Flight Inspection Responsibility. The FAA is responsible for:

a. Developing required resources, scheduling, and conducting flight inspections in accordance with this order and FAA Order 8200.1, current edition, to certify the MSBLS signal-in-space in accordance with the prescribed tolerances.

b. Analysis of the flight inspection data in sufficient detail to determine the adequacy of the MSBLS to perform its required functions. Recordings made during the flight inspections are the permanent records of facility performance.

c. Utilizing maximum effort on-station to afford NASA NAVAIDS Engineering the opportunity to achieve optimum performance of the ground systems. If discrepancies are found and corrected, flight inspectors shall assist in resolving facility deficiencies and retesting the facility prior to departure of the flight inspection aircraft.

d. Providing, on request, original flight recordings and/or electronic files for engineering analysis. The recordings will be preserved and promptly returned to AVN-210. Permanent copies of recordings may be obtained from AVN-210 and provided to NASA personnel.

e. Completing flight inspection reports in accordance with FAA and NASA directives. Flight inspection reports shall be accurate and describe facility performance and characteristics.

4. Certification. The FAA is responsible for commissioning, periodic, and special MSBLS flight inspections, as defined in FAA Order 8200.1, current edition, and applicable NASA directives.

a. Commissioning: Comprehensive testing to determine the capability of the MSBLS, as installed at a particular location, to support the Space Transportation System (STS) mission. Flight tests to demonstrate system capabilities over a large volume of coverage are performed, and tests to measure site peculiar characteristics may be conducted. A commissioning flight inspection is performed for an initial installation before the system is committed to operational support.

b. Periodic: Scheduled comprehensive flight inspections sufficient to demonstrate that the MSBLS continues to meet *commissioning standards* and support its operational requirements. The minimum frequency of periodic inspections shall be two years, and the inspection will be considered completed within the periodic interval, if accomplished from 60 days before until 60 days after the due date. More frequent inspections may be made when deemed necessary or as requested by NASA.

c. Special: Inspections performed outside the normal periodic interval. They may be used to define/ evaluate performance characteristics of systems, subsystems, or individual facilities. NASA shall be responsible for coordinating the flight inspection checks that are to be accomplished with the FAA, based on NASA requirements and type of maintenance performed on the equipment.

5. Checklist. The checklists (Figures 1, 2, and 3) outline the minimum evaluations, in the expected order of completion, required to certify the MSBLS system, per the facility configuration installed. NASA NAVAIDS Engineering may request checks for facility optimization not required by the checklist or referenced in the text. The FAA shall coordinate requirements and expected results with NASA.

Figure 1
MSBLS-GS FLIGHT PROFILE CHECKLIST

PROFILE TYPE	SYSTEM P/ B	INSPECTION		FLIGHT PROFILE					AZIMUTH		ELEVATION		DME
				AZ	EL (DEG)	ALT AGL	DISTANCE						
		C	P				START	END	ALIGN	ROLL	ALIGN	ROLL	ACCU
Radial	P	X	X	SCL	Note 2	8000	20	3	X	X	X		X
Arc	P	X	X	15 L/ R	5	8000	15	15	X		X	X	X
Radial	B	X	X	SCL	Note 2	8000	20	3	X	X	X		X
Arc	B	X	X	15 L/ R	5	8000	15	15	X		X	X	X
Approach	P	X	X	SCL	4	4300	10	Note 1	X		X		X
Radial	P	X	X	SCL	Note 2	2000	10	1	X		Note 4		X
Approach	P	X	X	CL	3	3200	10	Note 1	X		X		X
Approach	P	X	X	CL	2	1500	7	Note 1	X		X		X
Radial	P	X	X	L9	Note 2	8000	20	3	X		X		X
Radial	P	X	X	R9	Note 2	8000	20	3	X		X		X
Radial	P	X	X	L3	Note 2	8000	20	3	X		X		X
Radial	P	X	X	R3	Note 2	8000	20	3	X		X		X
Approach	B	X	X	SCL	4	4300	10	Note 1	X		X		X
Radial	B	X	X	SCL	Note 2	2000	10	1	X		Note 4		X
Approach	B	X	X	CL	3	3200	10	Note 1	X		X		X
Approach	B	X	X	CL	2	1500	7	Note 1	X		X		X
Radial	B	X	X	L9	Note 2	8000	20	3	X		X		X
Radial	B	X	X	R9	Note 2	8000	20	3	X		X		X
Radial	B	X	X	L3	Note 2	8000	20	3	X		X		X
Radial	B	X	X	R3	Note 2	8000	20	3	X		X		X
Radial	P	X		L6	Note 2	8000	20	3	X		X		X
Radial	P	X		R6	Note 2	8000	20	3	X		X		X
Radial	B	X		L6	Note 2	8000	20	3	X		X		X
Radial	B	X		R6	Note 2	8000	20	3	X		X		X
Approach	P	X		CL	1.5	1100	7	Note 1	X		X		X
Approach	B	X		CL	1.5	1100	7	Note 1	X		X		X

LEGEND:

P	Primary
B	Back-Up
C	Commissioning Type Inspection
P	Periodic Inspection
CL	Runway Centerline
SCL	System (MSBLS) Center Line
R/ L	Aircraft's right or left, as viewed inbound to the runway

NOTES:

1. Horizontal volume boundaries: AZ data collected ±13.5° right and left of MSBLS CL. EL data collected ±20° right and left of EL antenna.

2. Vertical volume boundaries: AZ/ EL data collected 1.3 – 23.0°

3. DME data collected at max range of 20 nm.

4. EL alignment not required

Figure 2
MSBLS-JRSW FLIGHT PROFILE CHECKLIST

PROFILE TYPE	SYSTEM P/ B	INSPECTION		FLIGHT PROFILE AZ	EL (DEG)	ALT AGL	DISTANCE		AZIMUTH		ELEVATION		DME
		C	P				START	END	ALIGN	ROLL	ALIGN	ROLL	ACCU
Radial	P	X	X	SCL	Note 2	8000	20	3	X	X	X		X
Arc	P	X	X	15 L/ R	5	8000	15	15	X		X	X	X
Radial	B	X	X	SCL	Note 2	8000	20	3	X	X	X		X
Arc	B	X	X	15 L/ R	5	8000	15	15	X		X	X	X
Approach	P	X	X	SCL	4	4300	10	Note 1	X		X		X
Radial	P	X	X	SCL	Note 2	2000	10	1	X		Note 4		X
Approach	P	X	X	CL	3	3200	10	Note 1	X		X		X
Approach	P	X	X	CL	2	1500	7	Note 1	X		X		X
Radial	P	X	X	L9	Note 2	8000	20	3	X		X		X
Radial	P	X	X	R9	Note 2	8000	20	3	X		X		X
Radial	P	X	X	L3	Note 2	8000	20	3	X		X		X
Radial	P	X	X	R3	Note 2	8000	20	3	X		X		X
Approach	B	X	X	SCL	4	4300	10	Note 1	X		X		X
Radial	B	X	X	SCL	Note 2	2000	10	1	X		Note 4		X
Approach	B	X	X	CL	3	3200	10	Note 1	X		X		X
Approach	B	X	X	CL	2	1500	7	Note 1	X		X		X
Radial	B	X	X	L9	Note 2	8000	20	3	X		X		X
Radial	B	X	X	R9	Note 2	8000	20	3	X		X		X
Radial	B	X	X	L3	Note 2	8000	20	3	X		X		X
Radial	B	X	X	R3	Note 2	8000	20	3	X		X		X
Radial	P	X		L6	Note 2	8000	20	3	X		X		X
Radial	P	X		R6	Note 2	8000	20	3	X		X		X
Radial	B	X		L6	Note 2	8000	20	3	X		X		X
Radial	B	X		R6	Note 2	8000	20	3	X		X		X
Approach	P	X		CL	1.5	1100	7	Note 1	X		X		X
Approach	B	X		CL	1.5	1100	7	Note 1	X		X		X

LEGEND:

P	Primary
B	Back-Up
C	Commissioning Type Inspection
P	Periodic Inspection
CL	Runway Centerline
SCL	System (MSBLS) Center Line
R/ L	Aircraft's right or left, as viewed inbound to the runway

NOTES:

1. Horizontal volume boundaries: AZ data collected ±13.5° right and left of MSBLS CL. EL data collected ±20° right and left of EL antenna.

2. Vertical volume boundaries: AZ/ EL data collected 1.3 – 23.0°

3. DME data collected at max range of 20 nm

Figure 3

MSBLS-JR FLIGHT PROFILE CHECKLIST

PROFILE TYPE	SYSTEM P/ B	INSPECTION		FLIGHT PROFILE					AZIMUTH		ELEVATION		DME
		C	P	AZ	EL (DEG)	ALT AGL	DISTANCE START	DISTANCE END	ALIGN	ROLL	ALIGN	ROLL	ACCU
Radial	P	X	X	SCL	Note 2	8000	20	3	X	X	X		X
Arc	P	X	X	15 L/ R	5	8000	15	15	X		X	X	X
Approach	P	X	X	SCL	4	4300	10	Note 1	X		X		X
Radial	P	X	X	SCL	Note 2	2000	10	1	X		Note 4		X
Approach	P	X	X	CL	3	3200	10	Note 1	X		X		X
Approach	P	X	X	CL	2	1500	7	Note 1	X		X		X
Radial	P	X	X	L9	Note 2	8000	20	3	X		X		X
Radial	P	X	X	R9	Note 2	8000	20	3	X		X		X
Radial	P	X	X	L3	Note 2	8000	20	3	X		X		X
Radial	P	X	X	R3	Note 2	8000	20	3	X		X		X
Radial	P	X		L6	Note 2	8000	20	3	X		X		X
Radial	P	X		R6	Note 2	8000	20	3	X		X		X
Approach	P	X		CL	1.5	1100	7	Note 1	X		X		X

LEGEND:

P	Primary
C	Commissioning Type Inspection
P	Periodic Inspection
CL	Runway Centerline
SCL	System (MSBLS) Center Line
R/ L	Aircraft's right or left as viewed inbound to the runway

NOTES:

1. Horizontal volume boundaries: AZ data collected ±13.5° right and left of MSBLS CL. EL data collected ±20° right and left of EL antenna.

2. Vertical volume boundaries: AZ/ EL data collected within 1.3 – 23.0°

3. DME data collected at max range of 20 nm

4. EL alignment not required

6. Flight Inspection Procedures: In-flight maneuvers consisting of descending approaches on runway centerline-extended at fixed elevation angles, level altitude radial flight on fixed azimuth and varying elevation angles, and lateral arcs at fixed elevation angles and varying azimuth angles either side of the azimuth antenna. Azimuth, elevation, and DME coverage and accuracy, (MSBLS accuracy and coverage in this order) shall be evaluated concurrently for each maneuver. The flight inspection crew shall coordinate with on-scene NASA personnel to determine the on-air MSBLS equipment/ antennas for all flight inspection profiles. Figures 4 – 7 indicate the MSBLS signal areas where airborne data is collected. Figure 8 is a flow chart, which represents the MSBLS flight inspection sequence, including flight inspection checks required subsequent to equipment adjustments.

a. Approaches. Multiple approaches are flown to runway centerline (RWY CL) and the MSBLS azimuth antenna centerline (MSBLS CL) between 1.5° and 4° elevation, to sample MSBLS position accuracy in the vertical plane. The flight inspection profile shall be terminated when the aircraft transitions out of the usable horizontal coverage of the System Under Test (SUT) identified as ±13.5° from the azimuth antenna and ±20° from the elevation antenna.

(1) Positioning. With the aircraft positioned on **RWY CL** extended, fly an elevation angle of 3°, starting at 10 nm. Additionally, fly elevation angles of 2.0° and 1.5° starting at 7 nm. With the aircraft positioned on **MSBLS CL**, fly an elevation angle of 4.0° from 10 nm.

(a) During commissioning-type inspections of each MSBLS-GS string, continue on the extended glide path angle on one of the RWY CL approaches to the touchdown point. Continue the landing roll the length of the runway and measure azimuth accuracy and coverage. On commissioning-type inspections of collocated MSBLS-JR and MSBLS-JRSW configurations (each string), continue on the extended glide path angle on one of the RWY CL approaches to the touchdown point.

(b) Fly one RWY CL approach on each MSBLS string, crossing runway threshold at approximately 50 ft. Conduct a low approach at 50 ft down the length of the runway or beyond the horizontal coverage of the SUT, whichever occurs first. Fly the MSBLS CL 4.0° approach to a point abeam runway threshold at approximately 50 ft.

(c) Terminate the remaining approaches at runway threshold.

(2) Inspection. Determine the capability of the primary and back-up MSBLS configurations to support multiple elevation angles by evaluating MSBLS accuracy and coverage throughout the approach until beyond the horizontal coverage of the System Under Test (SUT). Ensure azimuth coverage and accuracy of the MSBLS-GS from touchdown, down the full length of the runway, on both the landing roll maneuver, and the approaches flown 50 ft above the runway surface. The data sampling area may require alteration so as not to bias the MSBLS analysis as the aircraft passes abeam or over the SUT.

b. Lateral Arcs. Arcs shall be used to evaluate the lateral limits of the azimuth, elevation, and DME facilities within horizontal MSBLS coverage.

(1) Positioning. At 15 nm from the elevation site, arc 15° either side of MSBLS CL. The altitude shall be 8,000 ft (5°) above the elevation site.

(2) Inspection. Evaluate MSBLS accuracy and coverage to 13.5° both sides of MSBLS CL. Provide the NASA NAVAIDS Engineer with real-time AFIS-announced elevation “roll” results. Any noticeable elevation error imbalance over the course of the arc could be caused by a tilt in the scanning elevation antenna.

c. Radials. Level runs provide a cross-section analysis of the MSBLS-GS (see Figure 4) and MSBLS-JR/ JRSW (see Figure 5) guidance within vertical coverage at pre-selected azimuth settings.

(1) Positioning. Along the MSBLS CL, fly level runs at 2,000 ft AGL/ 10 to 1 nm and at 8,000 ft AGL/ 20 to 3 nm. Fly additional 8,000 ft AGL level runs/ 20 to 3 nm at angles offset 3, 6, and 9°, both sides of the MSBLS CL.

(2) Inspection. Evaluate MSBLS accuracy and coverage between vertical angles of 1.3 to 23.0°, at pre-selected azimuth angles. (See Figure 6) Provide the NASA NAVAID Engineer with real-time AFIS-announced azimuth “roll” results for the 8,000 ft AGL MSBLS CL run. Any noticeable azimuth error imbalance along the radial could be caused by a tilt in the scanning azimuth antenna.

d. DME. The MSBLS DME shall be checked on all runs and evaluated for accuracy and coverage throughout the service volumes.

e. Analysis. Maximum MSBLS azimuth and elevation system error is 0.05° within azimuth angles ±10° of MSBLS CL, and shall be allowed to increase linearly to ± 0.10° at azimuth angles ± 13.5° from MSBLS CL.

(1) The azimuth/ elevation error is acceptable if the mean alignment is less than ± 0.015° and 68% of the data samples collected fall within ± 0.05° of the zero baseline. This analysis applies separately to the overall measurement area and the Orbiter corridor.

(2) Standard deviation indicates the dispersal of data sample errors from the mean alignment. Advise the NASA NAVAIDS engineer if this value exceeds ± 0.05°.

(3) DME shall meet tolerances within the MSBLS service volume.

(4) Expected azimuth and elevation “roll” error is 0.10° or less.

NOTE: The Orbiter landing corridor is a cross-section of the azimuth/ elevation guidance proportional with the descent path of the Orbiter for the STS landings. The horizontal boundary of the corridor lies within 2.5° of true runway heading, and the vertical boundaries are defined in two sectors.

Sector One is defined as from 12,000 ft AGL to 2,000 ft AGL. This sector considers a heavyweight STS executing a 15.5° glide slope to an aiming point 9,000 ft before the runway threshold, and a lightweight STS executing a 21.5° glide slope to an aiming point 5,000 ft before runway threshold.

Sector Two is defined as from 2,000 ft AGL to 200 ft AGL. It consists of a 15.5° glide slope to an aiming point 9,000 ft before runway threshold, and an 11.3° glide slope to an aiming point of runway threshold.

The flight inspection crew shall communicate MSBLS results to NASA NAVAIDS Engineering to optimize the landing corridor. The Orbiter corridor shall be analyzed and reported separately from the entire flight inspection profile.

f. Tolerances. Mean azimuth and elevation alignment error shall not exceed 0.015° of the composite bias with respect to the airborne truth system. Composite bias is defined as the accumulative mean MSBLS error of *all combined* flight profiles. Azimuth and elevation errors are computed separately for tolerance application. Mean DME error shall not exceed 100 ft with respect to the airborne truth system.

g. Weather Limitations. MSBLS flight inspection is normally limited to fair weather conditions. At the discretion of the NASA NAVAIDS engineer, the flight inspection will be terminated if precipitation on the ground adversely affects the MSBLS signal propagation.

7. Reports. Flight inspection reports accurately reflect the operating parameters of the MSBLS. They are the means to certify the operational status of the facility and the quality of signals-in-space. AFIS-generated reports shall be utilized to report MSBLS flight inspection results. Interim flight inspection reports shall be provided to on-site NASA personnel on request. Final flight inspection reports and recordings shall be distributed and archived IAW FAA Orders 8240.36 and 1350.15. The MSBLS Flight Inspection Report page shall be provided as the final flight inspection report for each MSBLS string.

Figure 4
MSBLS-GS RADIAL FLIGHT

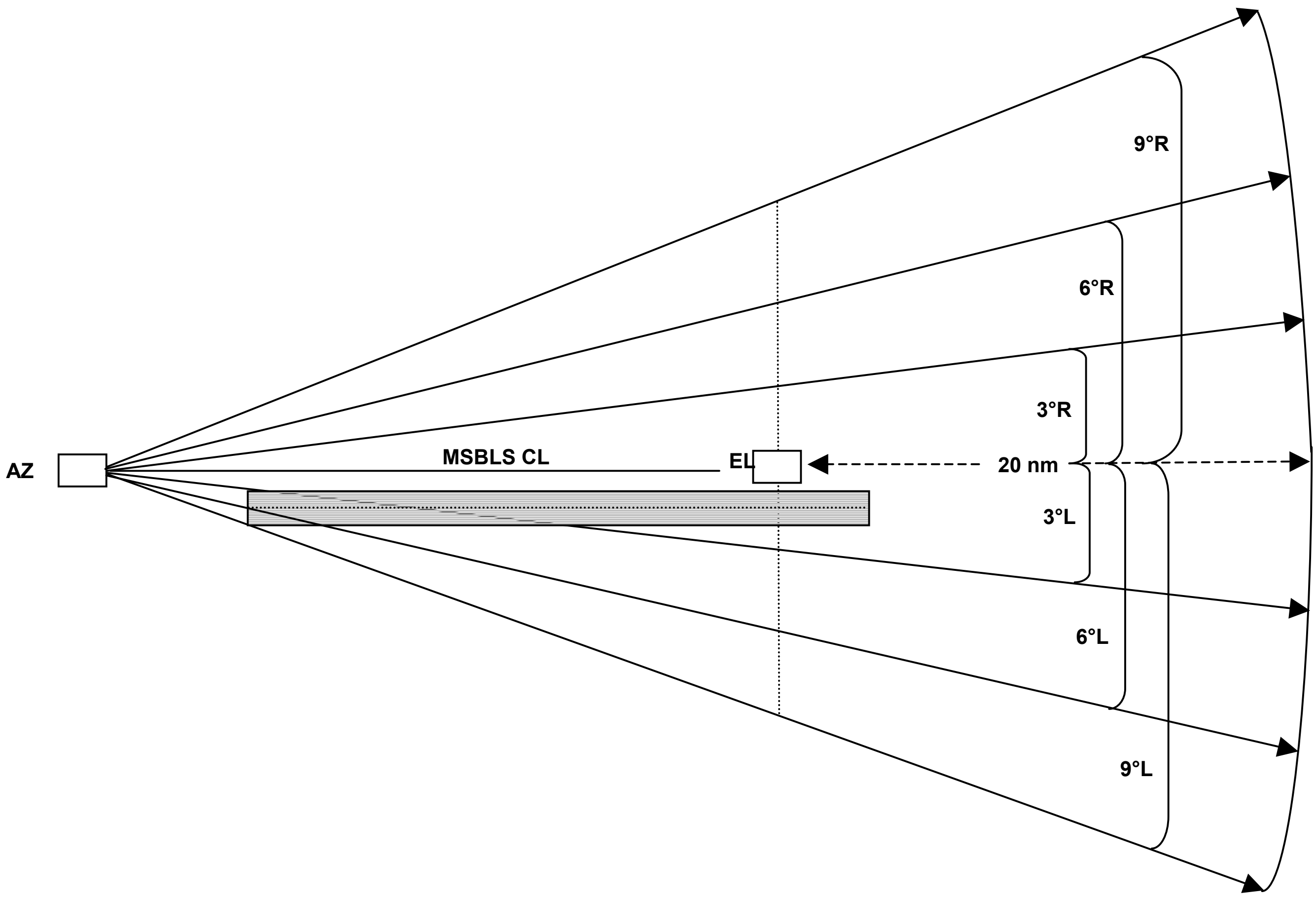


Figure 5
MSBLS-JR/ JRSW RADIAL FLIGHT

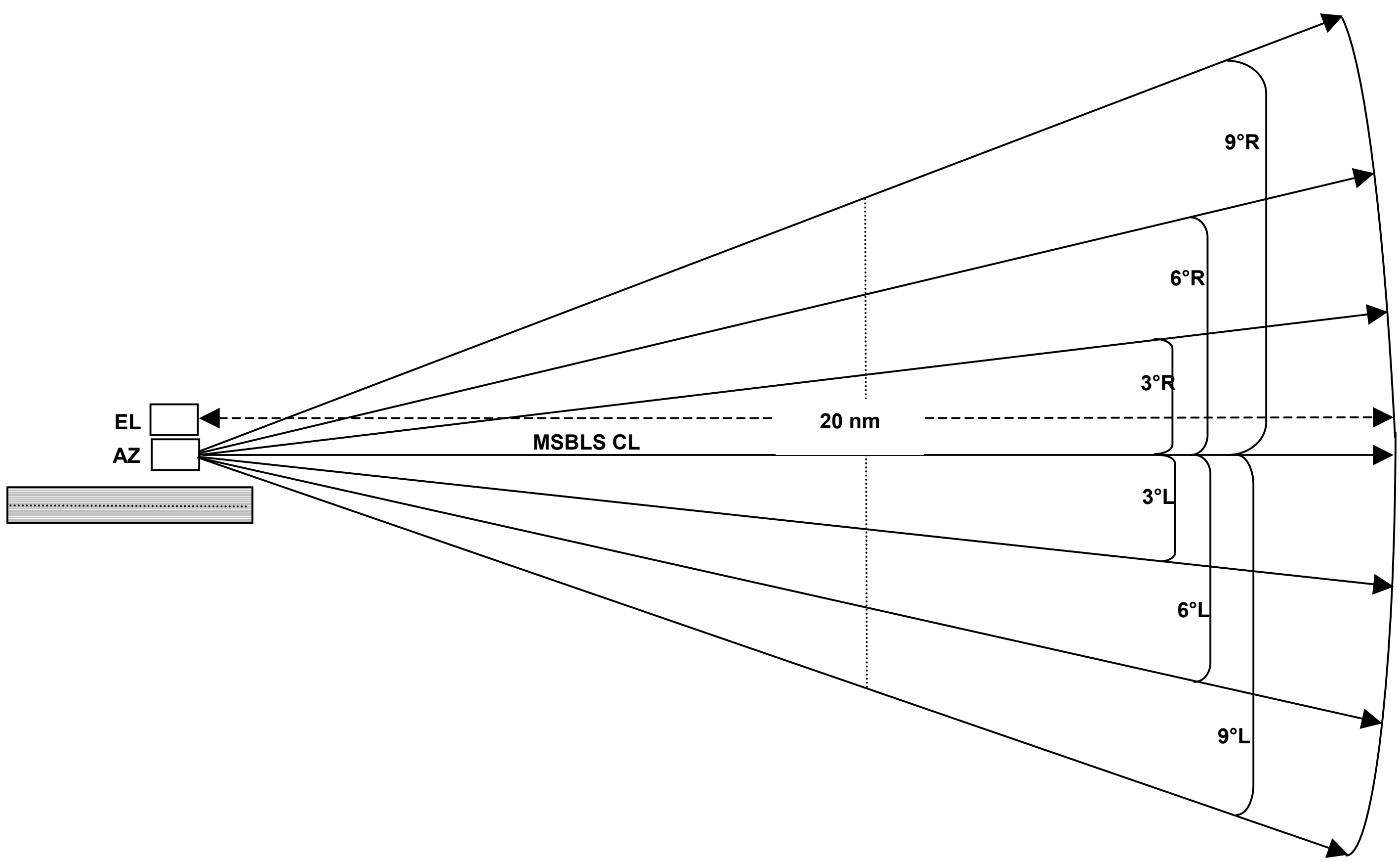


Figure 6
AZ/ EL VERTICAL FLIGHT INSPECTION SERVICE VOLUME

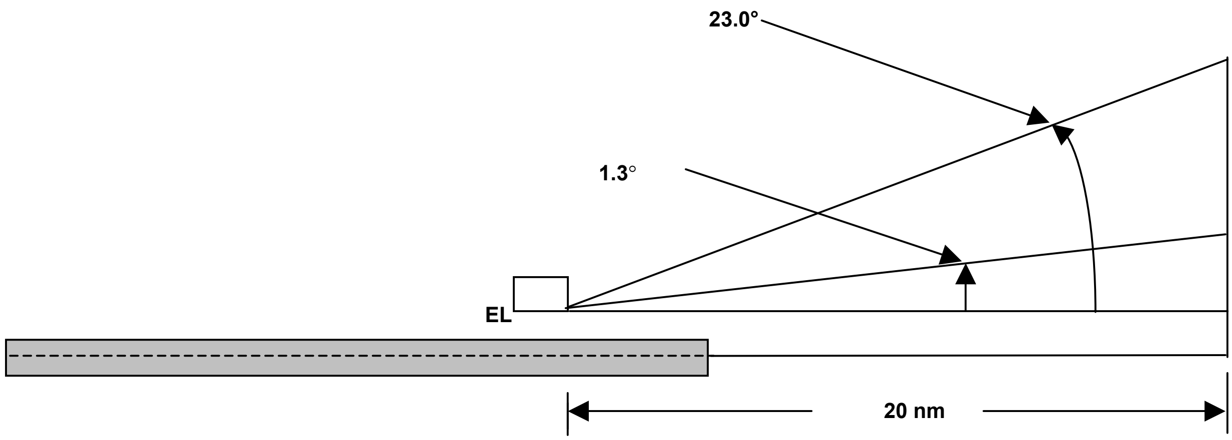


Figure 7
EL HORIZONTAL FLIGHT INSPECTION SERVICE VOLUME

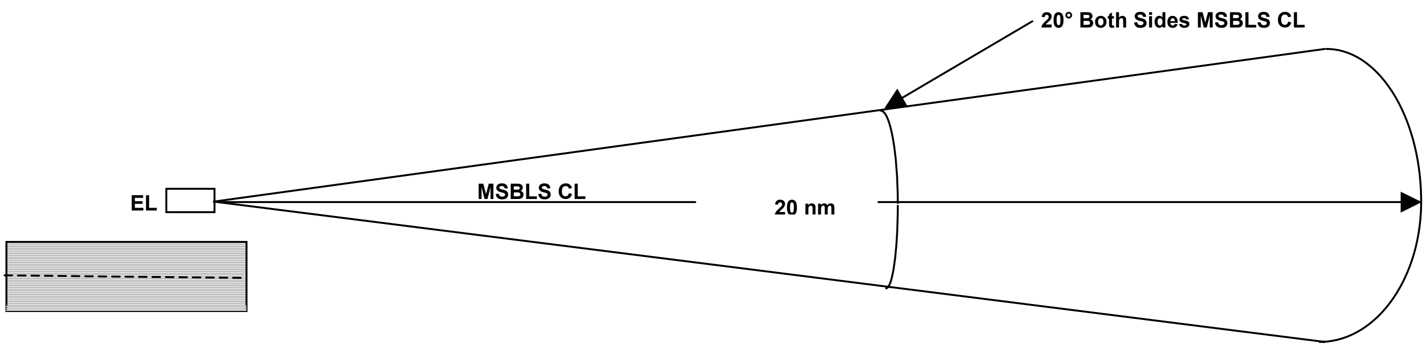
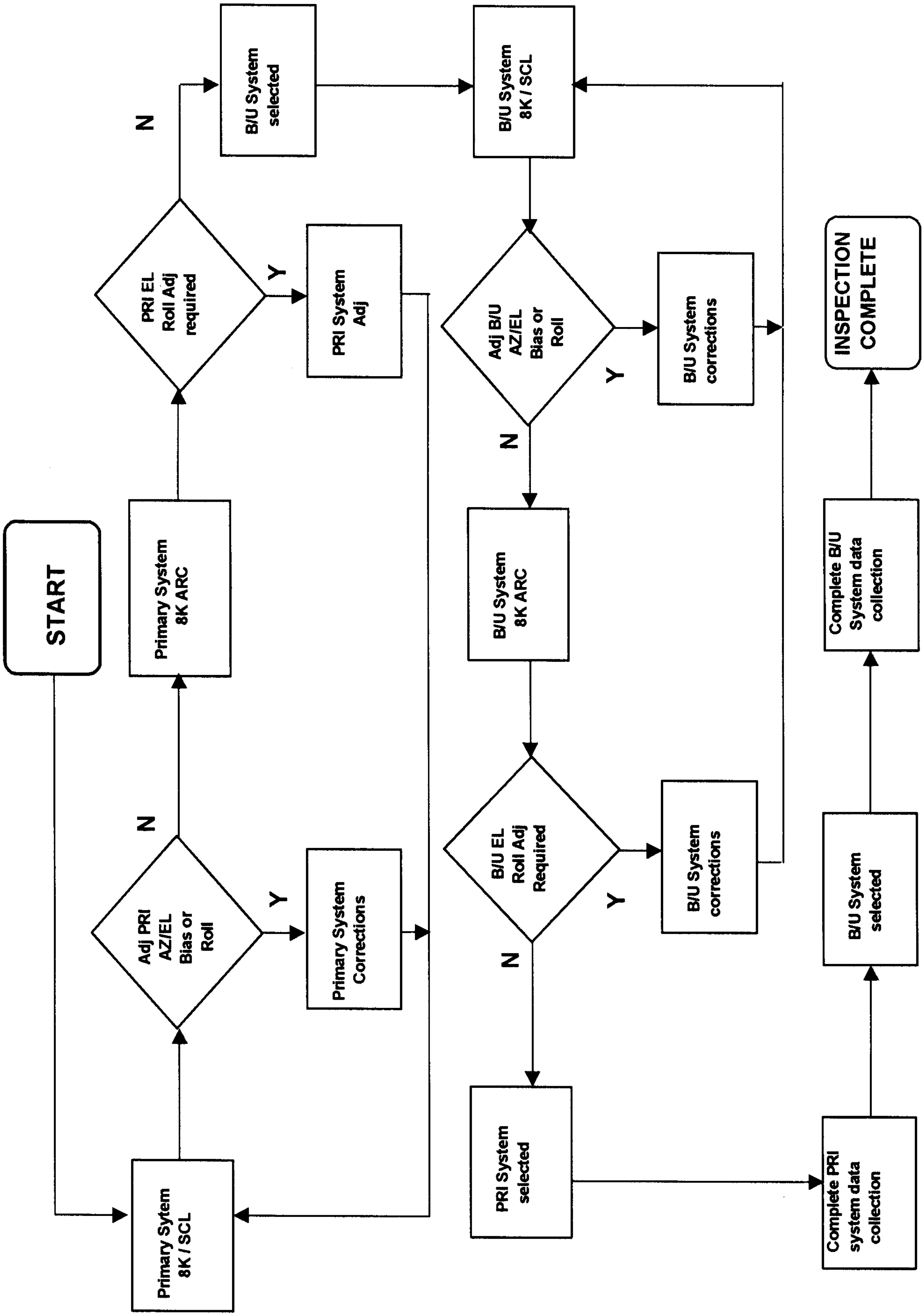


Figure 8

MSBLS FLIGHT INSPECTION FLOW CHART



APPENDIX 3. DEFINITIONS/ ABBREVIATIONS

AVN	Aviation System Standards
AZ	Azimuth
CL	Runway Centerline
DGPS	Differential Global Positioning System
DME	Distance Measuring Equipment
EL	Elevation
FAA	Federal Aviation Administration
FPO	Flight Procedures Office
GN&C Computer	Guidance, Navigation, and Control Computer
GS	Ground Station – A dual transmitter/ antenna “split-site” AZ/ EL MSBLS station
Hz	Hertz
ICD	Interface Control Document
JR	Junior – A single transmitter/ antenna collocated AZ/ EL MSBLS system
JRSW	Junior Switchable – A dual transmitter/ antenna collocated AZ/ EL MSBLS system
MSBLS	Microwave Scanning Beam Landing System
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NM	Nautical Mile
Orbiter	Space Transportation System (NASA Shuttle)
Orbiter Landing Corridor	Cross section of the AZ/ EL guidance proportional with the descent path of the Orbiter for STS landings
Roll	Least squares fitted line to the azimuth/ elevation tilt error
RWY	Runway
SCL	MSBLS system centerline
String	MSBLS AZ/ EL ground station as paired with an AZ/ EL antenna
STS	Space Transportation System (NASA Shuttle)
SUT	System Under Test